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THE MONIST.

LONGEVITY AND DEATH.[1]

IN CONNEXION with Professor Weismann's very noteworthy essay on *Death*, in my estimation one of the most important contributions to the literature of Natural Selection since Darwin died, it may be of interest if I here quote some passages from an unpublished essay of mine written in 1875 upon the same subject and dealing with it from somewhat the same standpoint—that of adaptation. It will be noticed that these passages for the most part refer to points which are unnoticed by Professor Weismann, and hence may be of use in any further consideration of the problem. The essay was not originally published, as Mr. Darwin, though he expressed his approval of the views it contained, considered them of so "speculative" a character as to render this at that time unadvisable. The passages to which reference has been made are here extracted verbatim.

Mr. Ray Lankester, in his valuable little treatise on *Comparative Longevity*, points out two or three causes which he thinks must have been instrumental in determining for each species what he aptly designates the normal potential longevity of the individual. While freely assenting to his opinions, I think there are other and still more important influences which he might have suggested—in particular that of Natural Selection.

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[1] The late Mr. G. J. Romanes placed the manuscript from which this paper is printed among the notes and appendices for his forthcoming Part II of *Darwin and After Darwin*. He bade me exercise my discretion with regard to the inclusion of such notes in that volume, leaving me free to decide whether they should be published in that or in some other manner. In consenting to the appearance of the following pages in *The Monist* I wish to reserve the right of republication in such form as may seem desirable.—C. LLOYD MORGAN.

If there is any conceivable way in which the agency of Natural Selection can be supposed to have assisted in determining the potential longevity of individuals, I think we have a right to conclude that the assistance so afforded must in all probability have been considerable, for Natural Selection, being of resistless power and constant operation, can scarcely be present anywhere without leaving good work behind it. Now we have, first of all, a strong antecedent probability that survival of the fittest must have had some share in determining the duration of life in individuals; for it is antecedently probable that so important a matter as the length of the individual's lifetime should in some way or another bear upon the interests of the species.

But in what way can the potential longevity of the individual affect the interests of the species? I think it may do so in several ways, as follows:—

Those species whose ancestral types have frequently been required to vary would have gained much during the history of their descent, by having their constituent individuals short-lived; for in this way a comparatively great number of opportunities would have been afforded for the requisite variation to arise: in other words, a comparatively great number of variations would have occurred in a given time. Hence it seems natural to infer that it is in the power of Natural Selection to affect the *curtailment* of individual life, wherever such curtailment would be of advantage to the species, that is to say, wherever *flexibility* of type is required. Of course, length of life is not the only factor which determines flexibility of type. There are at least three other such factors, (1) the period at which puberty sets in, (2) the number of times the individual breeds during its lifetime, and (3) the number of young which it bears at each time of breeding. Nevertheless, it is true that the length of life is a highly important factor, because, if the individual is short-lived, it becomes a necessary condition to the continuance of the species that parturition should be frequent. Or, more generally, there must be more or less of a direct proportion between the potential longevity of every species and the frequency of parturitions characteristic of that species—if not also of the number of offspring in each. Now, as Mr. Lankester has pointed out, there is, as a matter of fact, a highly remarkable correlation between potential longevity in the individual and frequency of parturition, as well as of numbers constituting the litter which are distinctive of the species. This correlation he attributes to generative expenditure acting directly to the curtailment of life; but in holding this view, I suspect that he is mistaking cause for effect. I do not think it is generative expenditure which causes curtailment of life, but that it is curtailment of life by Natural Selection which causes the high generative expenditure within the lessened period. It is as though all the conditions needed to secure flexibility of type were adaptively associated in these species which have survived in a comparatively fluctuating environment. Moreover, it is worth observing that all the organisms to which Mr. Lankester ascribes a practically unlimited potentiality of life, are organisms which, as far as we can judge, must always have been exposed to uniform conditions of life.

The essay then proceeds to consider death in general as due to adaptive causes, and concludes as follows:

It is too often forgotten by evolutionists that natural selection can only operate before and during the time at which an organism is capable of procreation. After the breeding age is past, the influence of natural selection is entirely withdrawn. For although it is true that a vigorous old age conduces to the longevity of the individual presenting it, he is not able to transmit his senile qualities to progeny, and thus survival of the fittest—which works for the benefit of the race—is in no way concerned with them. Of course senile vigor may be a residual effect of youthful vigor, and thus, as it were, an accidental result of natural selection; but *per se* it is not a result for the direct attainment of which natural selection can ever operate.

So far as this principle is concerned the organism may be regarded as dead so soon as it has ceased to procreate, and although one of the sequelæ of natural selection operating on earlier ages may be that of increasing the chances of vigor in old age, this, in relation to the objects of natural selection, is merely an incidental concomitant.

Consequently, any diseases which belong to old age will be allowed by natural selection to commit their ravages without let or hindrance, while diseases which belong to all earlier periods of life will be, as far as possible, eliminated. The way in which they are eliminated is by allowing those who succumb to them to die, and thus allowing those who do not succumb to breed—so bequeathing to progeny constitutions which are capable of resisting disease. But all such diseases as apoplexy, angina, etc., which belong chiefly to old age, are quite beyond the province of natural selection to control, for it matters not to the species how soon after the last offspring has been produced the parent organism dies.

Now, if this applies to disease, it must apply equally to normal physiological processes. If natural selection can inspire no hindrance to those abnormal tissue-changes which end in apoplexy or angina, neither can it inspire any hindrance to those normal tissue changes which lead to death from general decay, or, as it is said, from mere old age. Throughout its life there is perpetually going on in the individual organism a struggle between the processes of waste and repair. Before and during the age of procreation survival of the fittest is in close alliance with the forces of construction. But as soon as the age of procreation is passed, this alliance ceases; the forces of destruction are allowed full play, and therefore more or less rapidly the balance between them and their antagonists is overthrown; the organism dies.

Now, if these things are so, it follows that there ought to be a general relationship observable in all species between the age at which procreation ceases and death supervenes. In other words, individuals of species which breed early, or breed often, ought to die young. The only object which natural selection has in favoring the forces of construction before and during the age of procreation being that of securing the fittest progeny, so soon as the individual has yielded a sufficient number of such progeny, he has ceased to be an object of any concern to natural selection. Therefore, as I have just said, individuals belonging to species which breed early, or breed often, ought to die young. And this, generally speaking, is what we find to be the case. Indeed, it is the only general principle that can be found to hold throughout both the vegetable and animal kingdoms.

Prof. Ray Lankester, in his essay already alluded to, ascribes this correlation to exhaustion of vital energies in a measure proportional to the amount and rate of propagation. But according to the views here advocated, the correlation is really due to natural selection, and, as such, has a directly adaptive meaning.

GEORGE J. ROMANES.